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CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies

Complexity-Predictability Project Diagnosis model

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Abstract

For successful project management, it is essential to adopt a suitable project management approach. This approach must be based on a thorough understanding of the project characteristics in its context. In this paper we present a diagnostic model that aims to advance this understanding. We distinguish three project aspects, namely the project content, the internal context and the external context. Each of these aspects is assessed from two dimensions, namely the degree of complexity and the degree of predictability. Based on these dimensions, four project profiles can be derived: 1) design projects, 2) negotiation and expertise projects, 3) development projects and 4) negotiation, expertise and development projects. This diagnostic model aims to enhance a dialogue among key players about the approach to be followed with regard to the content and context of the project during the planning, execution and evaluation of major projects. The model can also be used as a lens to identify project risks and to propose mitigating actions.

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1. Introduction

During recent decades, our understanding of project management has developed rapidly. This development was on the one hand directed at refining classic project management approaches and on the other hand at creating new approaches. Traditional project management approaches emerged from the Operations Research discipline. Within this tradition, project phases and activities are defined on the basis of clear project goals and available resources. The project management approach is top-down, rational and linear and assumes that the project is not constantly influenced by external factors. Project managers who adopt this approach will not accept changes of scope, goals or resources during the project. They opt for stability and minimal interruptions. Quantitative approaches for project planning and risk management such as CPM, PERT and GERT are preferred [1]. At the same time, we observe alternative ways for approaching projects. The breeding ground for these lies in complex project contents and less predictable internal and external environments. Project goals are ambiguous and a balance must be sought between contradictory insights and interests that are not always clear at the outset. Within these alternative project approaches, the dialogue with the environment is actively pursued, and negotiations, adjustments and interruptions are seen as necessary to arrive at a jointly developed end product. Terms such as bottom-up, participation, negotiation, iterative, experimental, agile and scrum characterize these approaches [2].

Due to the coexistence of these partially conflicting approaches, management teams are often confused about the desired approach, while, as Pich et al. [1] stated, it is important for managers to understand the different project management approaches and how to choose among them. They feel, on the one hand, a pressure to demonstrate leadership, to formulate concrete project goals and to evaluate projects systematically, while on the other hand various interest groups wish to influence the project and continuous changes in the environment affect the project. In this paper we aim to reduce this confusion by proposing a diagnostic model that enables managers to understand why different project management approaches exist and supports them in adopting an approach that suits the circumstances.

2. Complexity-Predictability Project Diagnosis model

In line with contingency theory, we assume that an appropriate project management approach is contingent on a project's situational dimensions [1-4]. We distinguish two dimensions, the degree of predictability and the degree of complexity [1,4]. Each project has various aspects that can be classified differently on these dimensions. In line with the work of Pettigrew and Whipp [5] we distinguish the content of the project, the internal context and the external context in which the project is carried out. Below, the two dimensions are explained on the basis of the three project aspects.

Dimension 1: degree of predictability

The degree of predictability can relate to the project's content as well as to the internal or external environment. The main question here is whether sufficient information is available to execute the project without any intermediate changes or, in other words, unpredictability refers to situations where outcomes are unknown due to continually changing interactions [6], [7]. In a project with a high predictability, there are clear project objectives. The key stakeholders are familiar with the project and the organizational, functional and technical requirements are clear. In case of technological projects, the technology is available and familiar. The required project resources are straightforward, available and sufficient. The project has few unpredictable dependencies with other projects. In other words, there are no surprises.

In projects with a low predictability, the project goals are not completely fixed; these may need to be adapted or developed over time. This can be due to new insights from internal interest groups or to a changing environment and a lack of information. It is also unclear what resources are needed to successfully execute the project and whether these will be available. Internal and external stakeholders may change their attitudes during the project, for example because they did not initially oversee the project and its consequences. The project also depends on other projects that take place simultaneously. In case of technological projects, they have not been developed before and are therefore relatively unknown. In all, surprises can be expected, but their nature is undeterminable.

Dimension 2: degree of complexity

In case of low complexity, the project involves few and homogeneous components and few dependencies [8], [9]. This can relate to the technical as well as to the socio-political aspects of the project. Low complexity in terms of project content relates to a technically simple problem that can be solved in isolation by mono-disciplinary experts. Depending on the project content, these may be IT, legal or logistic experts. With a high complexity of the content,

experts from multiple disciplines will have to combine their insights to solve a non-trivial problem. In the case of low complexity in terms of internal or external environment, there are either relatively few interest groups involved or the agreement among interest groups is high. Interest groups can be the client, the project team, factions within the organization on whom the project is dependent, and external parties such as customers and suppliers. With a high socio-political complexity there is a chance of conflicts about the project between internal and external interest groups. For example, there is no agreement about the goals and resources, about the implementation strategy or about the effects on the organization.

Figure 1 shows the project management model resulting from these two contingencies. It includes four generic project types: 1) design-oriented projects, 2) negotiation and expertise projects 3) development projects and 4) negotiation, expertise and development projects.

		Complexity	
		Low	High
Predictability	High	1) Design	2) Negotiation and expertise
	Low	3) Development	4) Development, negotiation and expertise

Fig. 1. The Complexity-Predictability Project Diagnosis model with four project types.

Below we will give short descriptions of how these projects are characterized and of the approach that matches the situation. We will also illustrate each project type with an example.

1 *Design projects* are characterized by a high degree of predictability and few differences of opinion. Sufficient resources have been made available to realize the agreed goals. The project is managed in a hierarchical manner and the technically competent project team members know what is expected of them. Adequate project structures are important. With extensive design-oriented projects, advanced planning techniques are used to monitor the project. In technological design-oriented projects, the focus is on getting the technology working. An example of a design-oriented project is a new release of an existing and accepted company-wide ERP system.

2 *Negotiation and expertise projects* are characterized by a high degree of predictability, technical complexity and differences of opinion among interest groups. Interest groups think fundamentally different about the project's goals and resources, and the relative power of these groups determines the outcome. Project management should assess the power relations and respond appropriately and bridge differences in insight. Negotiations, adjustments, strategic use of time (breathers), pilots, use of incentives and timely involvement of influential stakeholders are appropriate strategies. A trade-off is possible in these projects: one can choose not to map out a complex, but predictable system completely but incorporate flexibility in the project management approach. This means that there are two options, as there may also be limited negotiation accompanied with the acceptance of unpredictability. The introduction of self-driving trains is an example of a project with high technical and political complexity combined with a high degree of predictability.

3 *Development projects* are characterized by both a low degree of predictability and low complexity. Those involved work together harmoniously to realize the globally agreed project goals. Mutual consultation and dialogues with suppliers and buyers lead to intermediate results in agile and scrum-like sessions that draw on learning and experimentation. An example of such a project is a group of dermatologists who work with Artificial Intelligence experts to develop a system that supports medical diagnoses.

4 *Negotiations, expertise and development projects* are characterized by the highest unpredictability and complexity: the project is technically complex, unpredictable and the actors involved fundamentally disagree. Future scenarios are being developed and the project is debated intensively. External and internal stakeholders, together with top-management, participate in these debates. Many publishers of newspapers go through such a process in the digitization

of news distribution. The outcome is uncertain, while journalists, publishers, readers and managers are participating in the debate.

In the introduction of this paper, we have indicated that a project has various aspects. We distinguished between the project content, the internal context and the external context [5]. This means that a project can be evaluated differently on each of these aspects. Below we will illustrate this with some examples. Example 1 is a project in which an organization-wide standard software system is being implemented. The external supplier is experienced and has sufficient know-how. Internally however, there is a lot of distrust and fear of losing jobs among the administrative staff. With regard to the technology and the supplier, a design-oriented approach can be adopted, while the internal environment requires a negotiation approach.

		Complexity	
		Low	High
Predictability	High	External environment Project content	Internal environment
	Low		

Fig. 2. Example 1, organization wide software system.

Example 2 is a project of a Dutch university that aims to establish a branch campus in China. This decision was made at the level of the Executive Board, after consultation with a Chinese partner. There is ambiguity about the approach and the outcome, which has to be determined gradually. The uncertainty pertains to the courses offered in China, research, funding and staff. There is fierce criticism, scepticism but also support among staff and students. External parties such as the ministry, political organizations and other universities also follow the project with a certain vigilance. The content of the project would require a development-oriented approach. At the same time, the level of agreement among the internal stakeholders is low. The external environment is awaiting.

		Complexity	
		Low	High
Predictability	High		
	Low	Content External environment	Internal environment

Fig. 3. Example 2, branch campus of a Dutch university in China.

The positioning of one or more project aspects is not static. During the project, the degree of predictability and the degree of complexity may change so that a different approach becomes necessary or possible. This can be illustrated with reference to Example 1. When fear and mistrust among the administrative staff is removed through a successful negotiation approach, the complexity of the internal environment shifts from high to low.

		Complexity	
		Low	High
Predictability	High	External environment Content	Internal environment
	Low		




Fig. 4. Nature of a project may change over time.

3. Diagnostic questionnaire and appropriate interventions

Currently, we are developing a diagnostic questionnaire which can be used to stimulate dialogue about the nature of the project among implementers and other key stakeholders. Below we present sample items that are related to project content (goals and scope), project resources (internal context) and external stakeholders (external context). In every item: ‘a’ statements relate to a low complexity and a high predictability, ‘b’ statements relate to a high complexity and a high predictability, ‘c’ statements relate to a low predictability and low complexity, ‘d’ statements relate to a low predictability and a high complexity.

Table 1. Examples of diagnosis questions.

Aspect	Questions
Project content	Which of the following statements is most true with regard to the <i>project goals</i> ? a) The project has one or few clearly defined and agreed upon project goals. b) Multiple ambiguous project goals cause disagreement among internal stakeholders. c) Project goals are fluid, but disagreement among powerful internal established and emerging internal stakeholders is unlikely. d) Project goals are fluid and diverging views about these changing, high level project goals among established and emerging internal stakeholders is likely.
	Which of the following statements is most true with regard to the <i>project's scope</i> ? a) The project has a limited scope or is related to a peripheral part of the organization. b) The project's scope is clear but large, related to the core of the organization and therefore conflict prone. c) The scope of the project is potentially large and yet undetermined. However, main stakeholders are cooperative and comfortable with this change under uncertainty. d) The scope of the project prone to change and may potentially affect many core processes; the affected stakeholders may disagree with this scope.
Internal context	Which of the following statements is most true with regard to the <i>project resources</i> ? a) There is clarity about the necessary resources in terms of finances, staff and expertise, these resources are available for the project. b) There is disagreement about the necessary resources; negotiations to make the resources available are necessary. c) There is uncertainty about the necessary resources, given the novelty of the project, but there is confidence that resources will be made available when needed. d) There is uncertainty about the necessary resources, given the novelty of the project. Ongoing discussions and conflicts about the availability of resources are likely.
External context	Which of the following statements is most true with regard to the most important <i>external stakeholder(s)</i> ? a) The project has a stable and harmonious external environment. External powerful stakeholders are consistently supportive, conflicts are unlikely. b) The project has a stable but diverse and ambiguous environment, conflicts with established external powerful stakeholders are likely. c) The project has a changing but harmonious and supportive external environment, conflicts with established or emerging external powerful stakeholders appear to be unlikely. d) The project has a turbulent and controversial environment, conflicts with existing and emerging external powerful and demanding stakeholders are likely.

Along developing the questionnaire, appropriate approaches and related interventions are being further developed. See figure 5 for some sample interventions per project type.

		Complexity	
		Low	High
Predictability	High	Design Advanced planning techniques Go-no go criteria at milestones	Negotiation and expertise Extensive stakeholder analysis Timely involvement of experts and/or interest groups
	Low	Development High frequency communication between team, buyers and suppliers Short-term sprints, longer-term flexible planning, allowing iteration	Development, negotiation and expertise Developing and debating scenarios Prototyping and probing

Fig. 5 Sample interventions relating to the approaches for the four project types

The diagnostic questions and subsequent approaches will finally be translated into a web-based toolbox that can assist project managers in the dialogue with stakeholders to propose well-argued implementation approach.

4. The value of the model

This paper has to related aims. The first aim is to help project managers understand why different project management approaches exist. The second aim is to propose a diagnostic model that supports them in adopting an approach that suits the circumstances. With regard to the first aim, the model allows us to put the wide range of classic and modern project management approaches in the framework of two dimensions: predictability and complexity, and to distinguish between a project's content, internal context and external context. With regard to the second aim we have shown that particular project characteristics point towards a particular approach. The project diagnosis model can be used before, during and after projects. Up front, it can contribute to a well-grounded choice of a project management approach and provide input for project planning. During the project, it can provide insight into the causes of possible problems and suggest adjustments. During a project evaluation, the model can contribute to a learning process in relation to future projects. The model can also be used to identify project risks and to propose mitigating actions.

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